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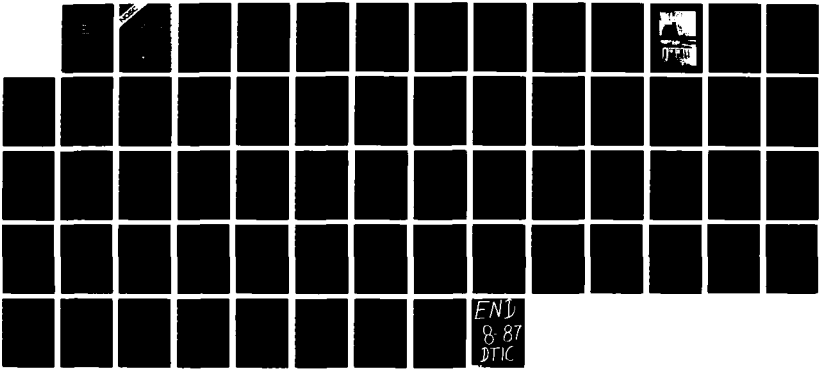

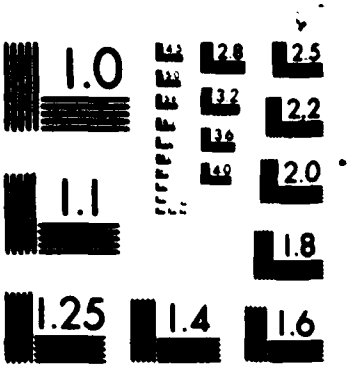

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August 1986

Real-Time Acquisition and Processing System (RTAPS)

VERSION 1.1.
Installation and User's Manual

David Bower
Computer Sciences Corporation

S. H. Lieberman
NOSC

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Real-Time Acquisition and Processing System (RTAPS) is an integrated hardware/software system designed to provide data acquisition, storage, and real-time processing and graphic display of sensor and navigation/position data for the Marine Environmental Survey Capability (MESC) developed by NOSC Code 522. This manual provides a description of the modularized system and gives detailed instructions for the installation and operation of the system.

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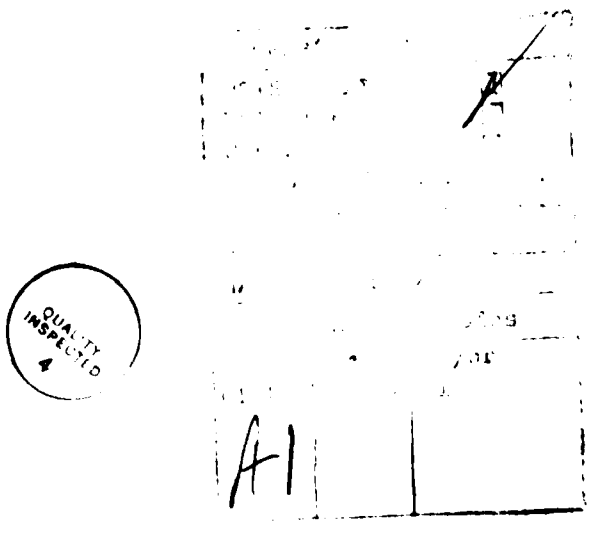

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1.0 GENERAL DESCRIPTION

The Real-Time Acquisition and Processing System (RTAPS) is a hardware/software system designed to provide data acquisition, storage, real-time processing, and graphic display of sensor data (physical, chemical, and biological) and navigation/position information for the Marine Environmental Survey Capability (MESC). MESC is a flexible, modularized system developed by the Marine Environment Branch of Naval Ocean Systems Center (NOSC) to provide rapid continuous measurement and mapping of environmental parameters in estuarine and marine environments.

RTAPS uses off-the-shelf acquisition and processing equipment programmed exclusively in procedural, high-level language. An integrated, modular hardware/software system is employed that uses one processor for acquiring data from a large variety of sensors and broadcasting the data to one or more microcomputers for storage and subsequent processing and display. The basic relationship and function of the subsystems are shown schematically in figures 1 and 2. The overall hardware system configuration is shown in figures 3 and 4.

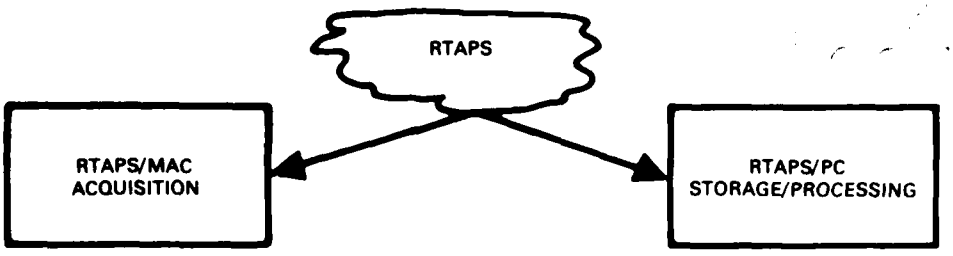


Figure 1. RTAPS major task divisions.

The use of two or more computers provides a parallel processing capability without requiring the use of a more powerful (and more expensive) mini-to-mainframe computer in the field sampling environment. The pseudo-multitasking software of the RTAPS/personal computer (PC) subsystem permits optimization of storage and processing tasks without the risk of data loss during acquisition because that task is handled independently by a separate machine. The use of multiple PCs also provides a means whereby different computation or input/output (I/O) activities can be performed on separate machines executing the same software by simply flipping a "software switch" in real-time or during postprocessing. Finally, multiple processors provide backup machines for critical tasks in the hostile environments encountered during field sampling programs.

RTAPS was designed to sample a wide range of signal types at relatively slow acquisition rates. Input signals can vary from analog signals of a few mV to 10 V, as well as digital representations. As a dedicated acquisition system, RTAPS can sample 20 analog input channels at a 0.5-Hz rate. Specific

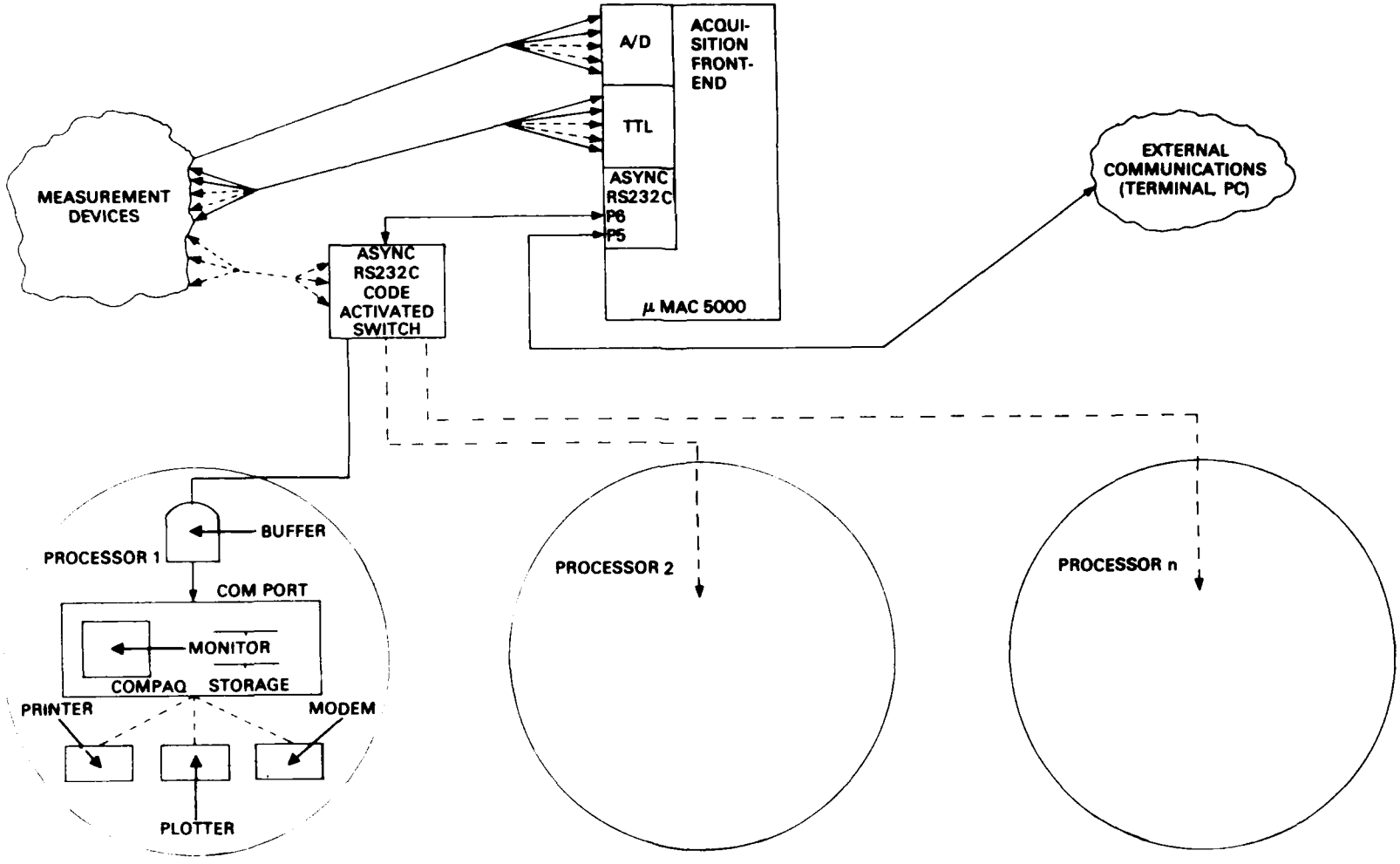


Figure 2. RTAPS hardware component diagram.

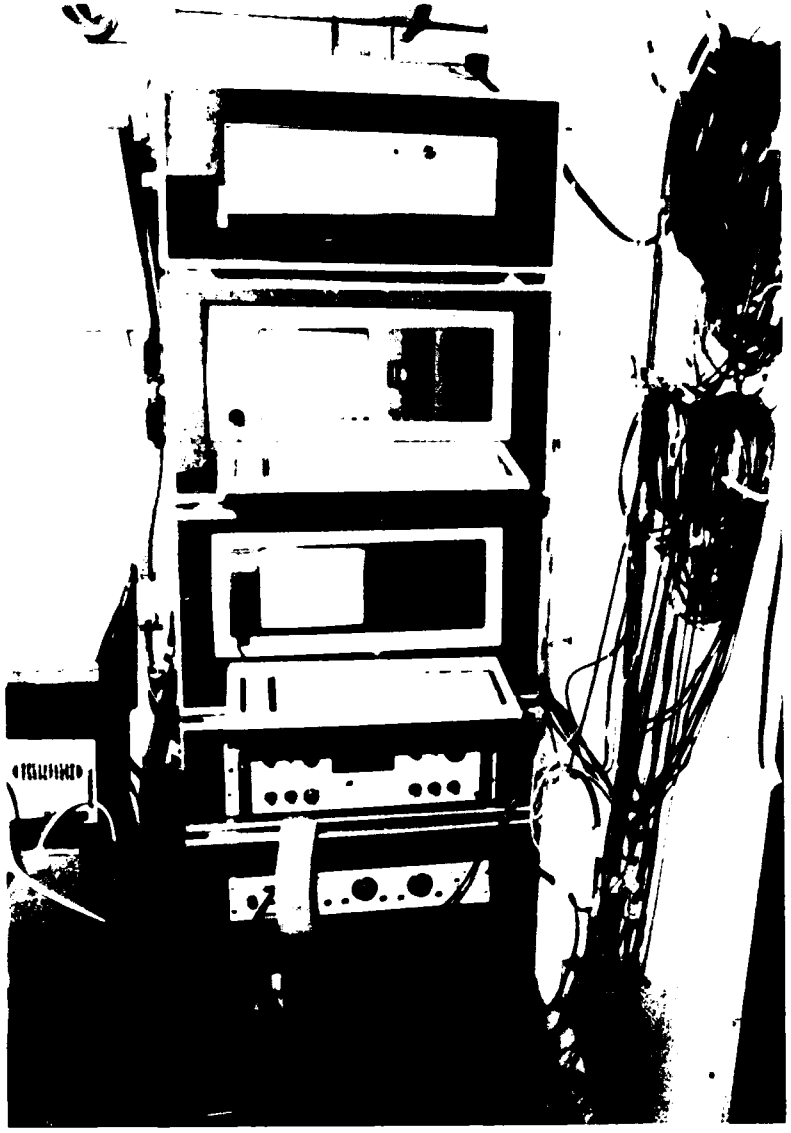


Figure 3. RTAPS systems components.

Figure 4. RTAPS monitoring instruments.

drivers are resident on board the acquisition subsystem to accommodate binary coded decimals (BCD) and RS232 input from sampling devices, such as an Innerspace Technology 412 digital fathometer, a Seabird Model 11 conductivity-temperature-depth (CTD) system, and a Motorola Falcon 484 microwave positioning system. Up to 60 channels of 0- to 10-V analog input can be multiplexed at a 50- to 100-Hz rate.

Nominally, the required hardware and software components implementing the system are listed below:

a. μMAC 5000 measurement and control system (Analog Devices)

b. PC-compatible computer with

*512-K random-access memory (RAM)

*Dual DS/DD floppies (one floppy, one hard drive recommended)

*1-2 ASYNC (RS232C) com: port (two recommended)

*8087 co-processor (optional)

c. Software:

1. BetterBasic (Summit Software) incrementally compiled, procedural programming language (8087 option if desired).

2. WOS (Workstation Operating System) for IBM-PC analog devices.

3. PC-DOS version 2.0 or later.

RTAPS has been tested on board MESC under field conditions. It has also been used under laboratory conditions for research and to monitor the bioassay system. The following sections provide a brief description of the sampling and processing structure of the measurement and control (MAC) and PC subsystems. Detailed instructions for installation and operation are given in sections 2 and 3, respectively.

1.1 RTAPS/MAC

The μMAC 5000 is a single-board acquisition/control processing system. The resident read-only memory (ROM)-based, on-board language is called MACBASIC. The language is incrementally compiled and procedure-oriented. It is run on an 8088 processor with 56K of available user RAM.

The master board features 12 isolated (up to 1000 V) differential analog input, 8/8 transistor-transistor logic (TTL)-level I/O channels, and two RS232 ASYNC communications ports. The analog to digital (A/D) is a 14 bit (13+ sign), multiplexed integrator. Slave boards can be added to bring the total number of analog channels to 60. Add-on boards are also available for additional digital and analog I/O.

RTAPS/MAC's software function is to receive data input at user-selected sampling intervals, time-mark, and consolidate the data into an output record that is easily "digestible" for the waiting RTAPS/PC processor(s) (figure 5). It sends the "packet" to the outside world via its ASYNC port(s). It performs no additional processing activities.

A more detailed I/O functional diagram is shown in figure 6. The acquisition subsystem is the master device in the sampling framework. In other words, digital devices, such as the Seabird unit, Mini-Ranger, and fathometer must be "polled" by the processor before their data may be input and integrated into the resulting output data stream. Analog channels are sampled via the on-board A/D in conjunction with digital inputs. The system is configured to incorporate a value field for each channel (regardless of its origin, analog or digital) in each output record sent to RTAPS/PC.

The subsystem includes software to perform multiplexing I/O functions via a Western Telematics CAS-41 code-activated RS232C switching device connected to either ASYNC port. The multiplexing feature does not have to be used. However, it is required if RS232C sensor input and output are routed via the same physical port on the μMAC.

Once sampling has been initiated, RTAPS/MAC operates independently from any external communications requirement. This means any device may be connected or disconnected to/from its I/O pathways without interfering with acquisition. Setup and cabling for the μMAC are described in section 2 of this manual.

1.2 RTAPS/PC

The software package is designed to store, process, and display information received from the front-end acquisition subsystem (RTAPS/MAC). It may be executed on any PC-compatible microcomputer system using BetterBasic under MS-DOS 2.0+. During execution, it provides the following user-selectable functions (tasks).

a. Data storage

   Sequential ASCII text files to available floppy or hard disk. These data may be calibrated or recorded as received from RTAPS/MAC.

   Random-access files (hard disk only), version 2.0.

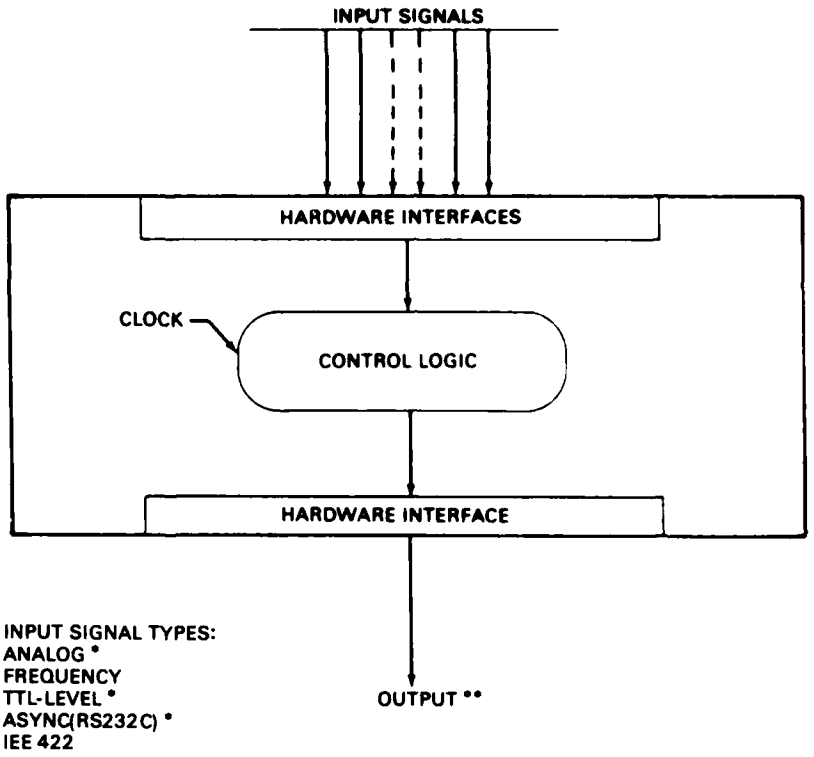
b. File documentation

c. Calibration

d. Time-series display

   Printer-Epson compatible

   Plotter-HP/GL compatible



* Input signals used by the current RTAPS/MAC system
** Currently RS232C is used for output data records

Figure 5. RTAPS/MAC. The principal purpose of the front-end system is to package diverse signal types into well-defined data records for communications with other processors.

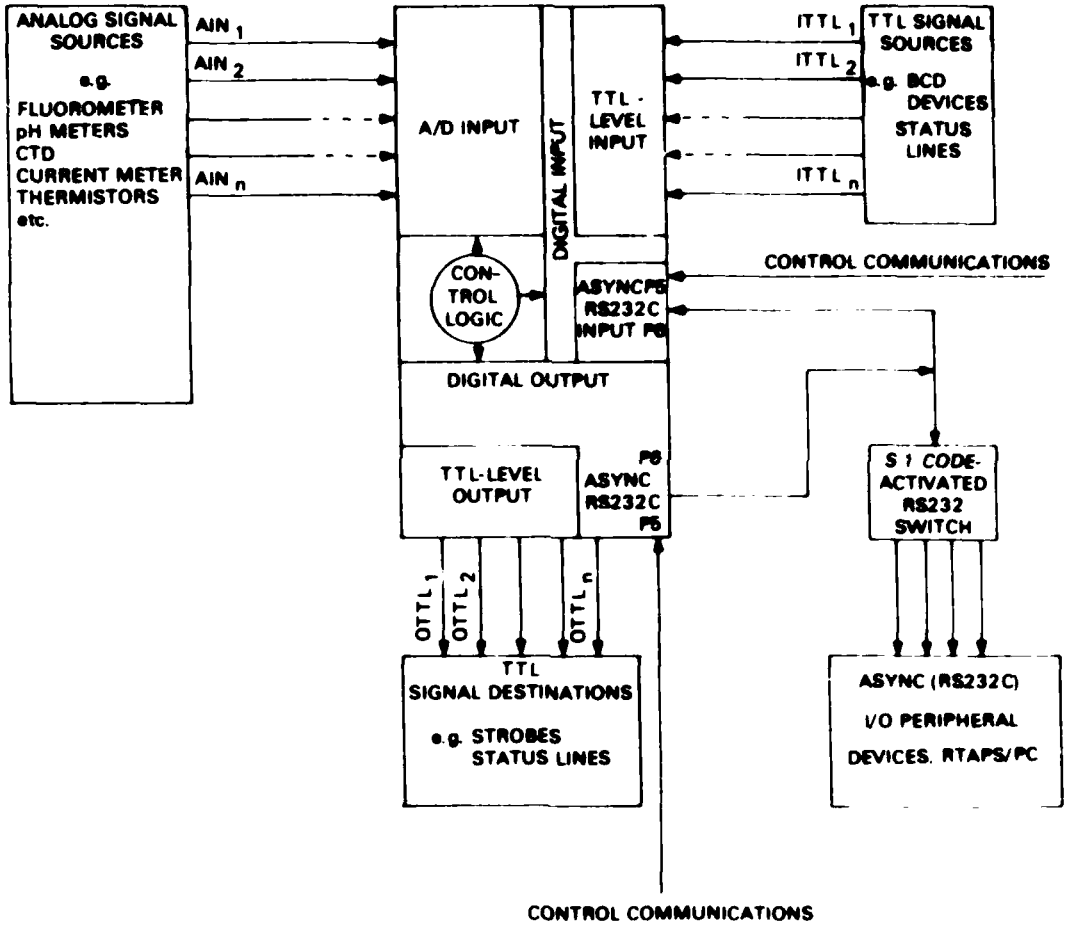


Figure 6. Detailed I/O diagram of acquisition subsystem (RTAPS/MAC)

e. Navigation display overlays (cathode-ray tube (CRT) or plotter), version 2.0.

f. Digitized map overlays (CRT or plotter), version 2.0.

Tasks may be changed, defined, or discontinued during program execution (real-time) or system start-up. The text file data storage task is prioritized to preclude the possibility of system overload and data loss (data will be recorded before any other selected processing activities are performed).

The working data may be input via the COM1: port or disk data file. This allows postprocessing and real-time execution compatibility. Map overlays must be pre-digitized and present in disk files in a predefined format (to be specified in RTAPS version 2.0+).

2.0 RTAPS INSTALLATION

2.1 Analog Input

The analog channels are routed to the μMAC 5000 master or 4010 add-on board via screw-terminal inputs on the AC1800 or AC1814 edge connectors installed on the front of the master/add-on board. The physical location of channel input ports is shown in figure 7. The 4010 add-on board is physically the same dimensions as the 5000 master and is connected to the 5000 via a bus cable or the plug-in chassis. Each add-on provides 12 analog and 8/8 in/out TTL level channels.

If QMX01 input isolation modules are being used, you must use AC1800 screw-terminal input connectors. If QMX03 high-isolation, low-level amplifiers are installed on the 5000 or 4010 board and the analog input level exceeds 100 mV, AC1814 100:1 input connectors must be used (in this case specify an input range of 6 in the initialization file, section 3.4.2.1).

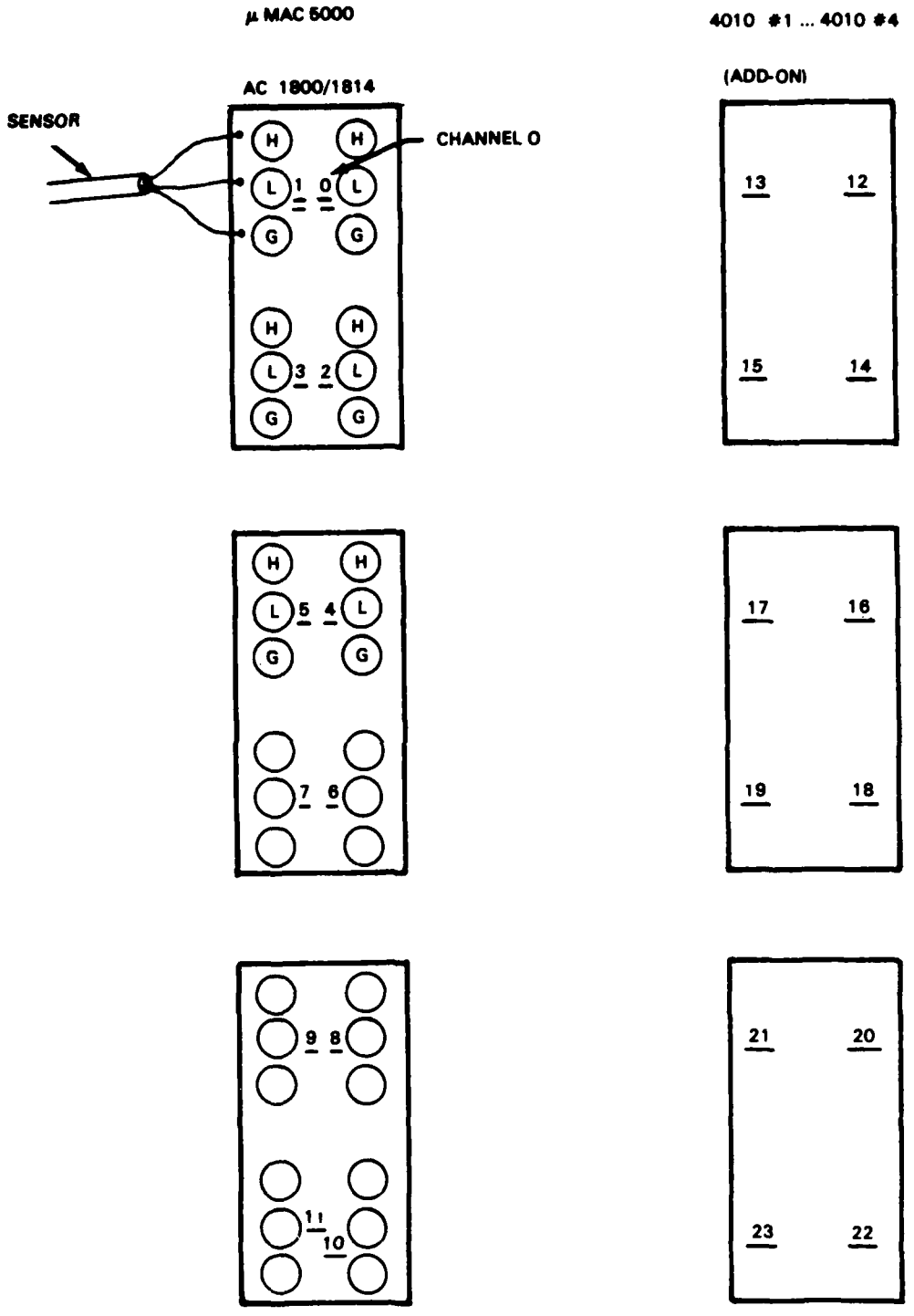
2.2 TTL BCD Input

The Innerspace Technology Model 412 fathometer communication requires the addition of at least eight input TTL-level channels to the μMAC 5000 master board. RTAPS is currently configured to use a 4010 add-on unit, which provides 8/8 TTL channels as well as an additional 12 analog input channels. The 4010 must be included if the fathometer is included in the sampling configuration. The BCD cable configuration is shown in figure 8.

2.3 RS232C

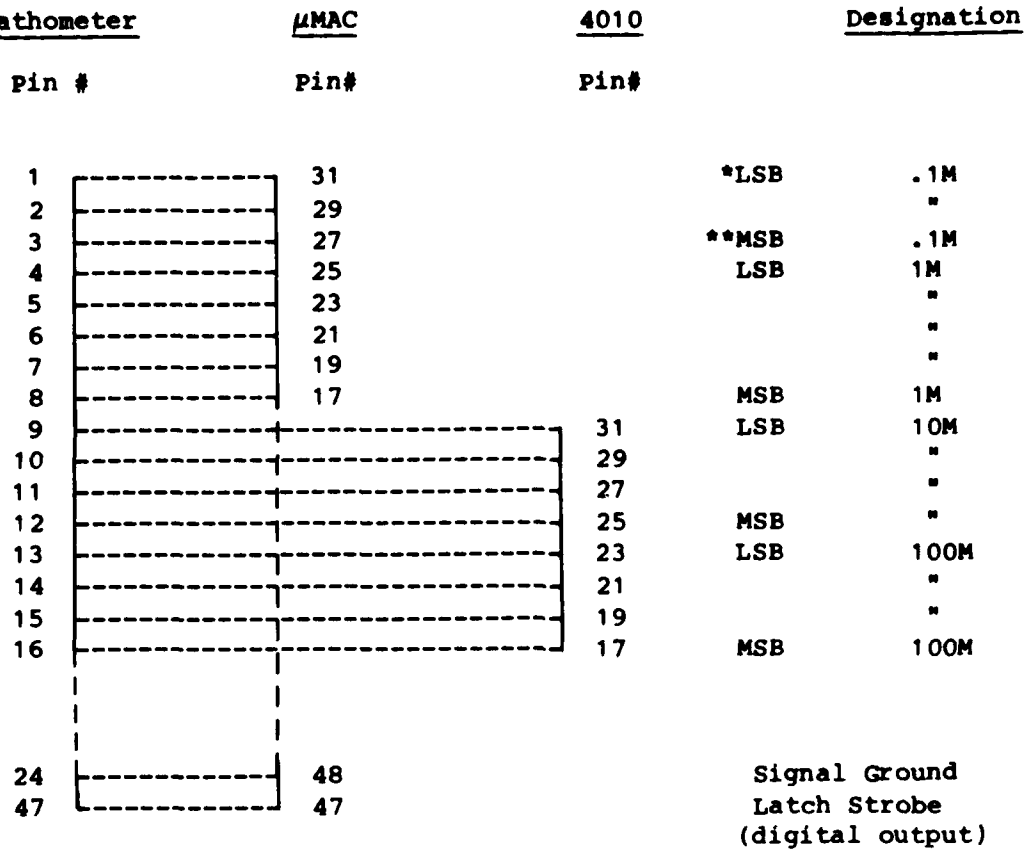
All RS232 digital I/O is performed using the following data transmission characteristics:

Baud	:	9600
Parity	:	None
Data	:	8 bits
Stop	:	1 bit



H - Differential analog high voltage in
L - Differential analog low voltage in
G - Guard (not used if QMX03 modules are installed)

Figure 7. RTAPS/MAC analog input locations (front edge of board).



* Least significant BCD bit
** Most significant BCD bit

Figure 8. Cable configuration to Innerspace 412 fathometer.

2.3.1 WOS. WOS is the package provided by Analog Devices for communications between the μMAC and IBM-PC. It is used to transmit/compile the RTAPS/MAC subsystem source code and to initiate program execution. The wiring diagram used for WOS communication is shown in figure 9.

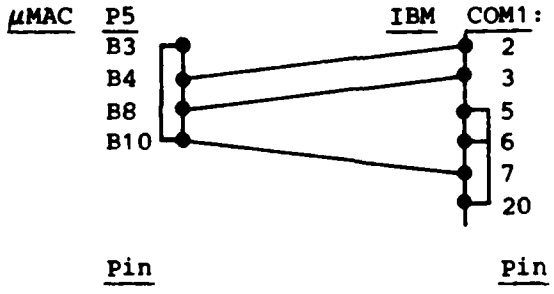
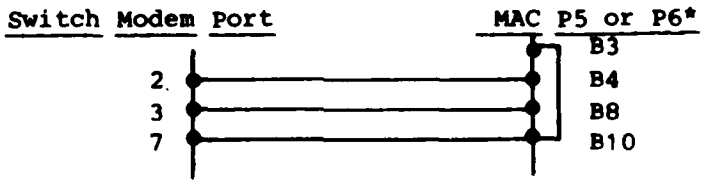


Figure 9. WOS to μMAC cable configuration.

2.3.2 Code Activated Switch (CAS) (Western Telematics CAS-41)

The CAS is configured to accept two-character mnemonic codes that control the active port(s). The DIP switches inside the switch must be configured to use ESC (27_{10}) as the reset character. The generation of codes to regulate switching is performed by the RTAPS/MAC software subsystem. The user I/O specifications are derived from the initialization file (section 3.4). The user is not required to use the mnemonic codes that control CAS operation.

2.3.2.1 μMAC to CAS. The switching device is used to communicate with input devices individually and/or provide output to one or more RTAPS/PC computers. The wiring configuration is shown in figure 10.



*P6 recommended

Figure 10. μMAC to code-activated switch cable configuration.

2.3.2.2 CAS to PC Com: Port. Communication cabling from the code-activated switch to IBM-PC COMX:** port is shown in figure 11.

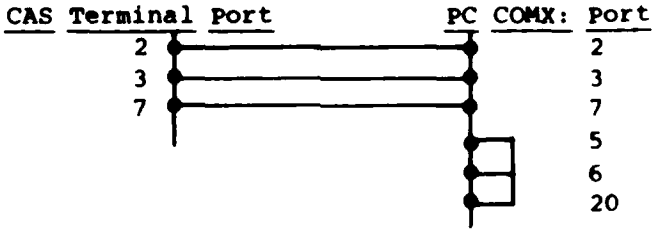


Figure 11. Code-activated switch to IBM-PC COMX.

**COMX: refers to either COM1: or COM2:. RTAPS/PC currently uses COM1: for data input.

2.3.2.3 CAS to Falcon 484. The switch cable configuration to the Mini-Ranger Falcon 484 is shown in figure 12 and cabling to the Seabird deck unit in figure 13.

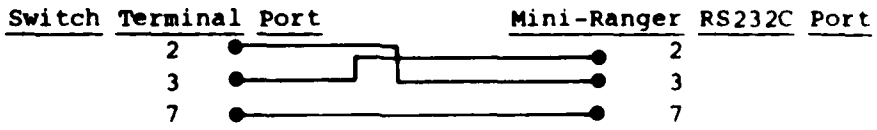


Figure 12. Code-activated switch to Falcon 484 cable configuration.

2.3.2.4 CAS to Seabird Model 11 Deck Unit

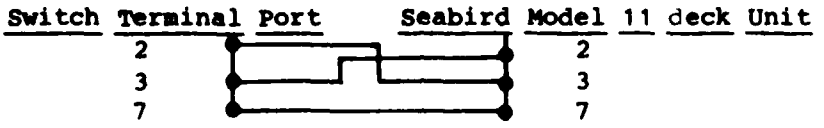


Figure 13. Code-activated switch to Seabird deck unit.

Note: If the switch is not used, the cabling should be routed in a straight-through configuration (figur 11 shows that the switch is wired on a pin-to-pin basis to the PC COMX: port).

2.3.3 External (In-line) Buffers. Individual applications may require the insertion of an external serial-to-serial buffer between specific system components. This provides an added guard against data loss due to temporary processing slowdown or floppy disk changes. Buffers may be used between the code-activated switch and IBM-PC system and/or between the IBM-PC and hard-copy output devices (printers, plotters). Specific cabling for external buffers is not shown here.

2.4 Power (μMAC 5000)

Power to the Micro MAC 5000 is provided through the card-cage chassis or stand-alone connector. The computer requires 115 VAC with 60 Hz or 24 VDC. Consult the μMAC 5000 operations manual, chapter 1, for specific connections.

2.5 BetterBasic Installation

RTAPS/PC software is implemented in BetterBasic,* version 1.1. The user must configure the language prior to running RTAPS and execute the package under the optimum configuration. We recommend using a hard disk drive.

Procedure -

a. Copy the composite BetterBasic files onto the target disk. You may choose to install the package in its own directory. If so, a comfortable text editor is useful, such as Wordstar or Ed. The editor should be contained within the new directory or accessible using PATH. operations.

b. The BetterBasic configuration information is contained in the file CONFIG.COM. Execute it by entering: Config <CR>. The configurator will ask a series of questions. Use defaults with the following exceptions:

* Summit Software Technology, Inc.
P.O. Box 99
Babson Park, Wellesley, MA 82157

Prompt		User Response
Use 8087	?	If you have a coprocessor and have purchased the 8087 math package, enter "Y".
DOS 2.X	?	Yes
Graphics	?	Y
Play Statements	?	Y
Event Statements	?	Y
Chain Statements	?	Y
# of Chain Bytes	?	2000
SYSCALL or SHELL	?	Y
# of Shell Bytes	?	64000
Precision	?	8 (without coprocessor)
XMEM and Strings	?	N
Status Line	?	N
Display Function Keys	?	N
Specify Stack Size	?	N
User Modules	?	N

2.6 PC Peripherals

The following comprise the recommended hardware/software configuration for optional peripheral devices.

2.6.1 Printer. The Epson-compatible printer should optimally be interfaced through the PC's parallel, centronics port. It should be configured as lpt1: (as the MS-DOS device). This is the MS-DOS designation. An external printer buffer will help to facilitate rapid communications to the printer.

2.6.2 Plotter. The current version of RTAPS uses the COM2: port as the RS-232C interface to the plotter. Its device designation is lpt2:. The interface baud rate may be specified using the MODE command prior to entering the BetterBasic environment.

```
For example:  MODE COM2:  2400,e,8,1
              MODE lpt2:  =COM2:
```

will properly configure the plotter as device lpt2:.

Alternatively, the recommended method of plotter device specification is to use the AST* superspl package, which provides an internal buffer area for plotter communications. You will need the file superspl.com. To configure the system, enter the command:

```
Superspl lpt2: = COM2:/rate = 2400,n,8,1/on = cts/m = 64
```

This sets up an internal printer buffer 64 Kbytes wide for lpt2:.

*AST Research, Irvine, CA 92714

Note: You must buffer the plotter, either internally or externally. The hardware handshaking does not always appear to function and may result in a buffer overrun on board the plotter. An IEE 488 interface has not yet been used with RTAPS. If you wish to connect via this interface, a code modification may be required. The "open" call for lpt2: is performed in the procedure tsinf. Cabling information is available in the plotting manual.

2.7 Recommended System Configuration

Many configurations are possible. The input-output options are designed to provide a maximum amount of system flexibility. The most basic configuration (single-PC and no RS232 monitoring devices on-line) is described below.

PRINTER: Connect an Epson-compatible printer to the Centronics parallel port.

PLOTTER: Connect the plotter to COM2: (configured as LPT2:).

DATA INPUT/OUTPUT: Connect the COM1: port on the PC to P5 on the MAC.

This configuration will allow the execution of WOS for initialization and output of data records from the μMAC to the PC during acquisition. The data output specification (section 3.4.2.3) must be entered as "0:-" in the initialization file to direct acquired data records to the COM1: port from P5 on the μMAC. If additional RS232 sensors are used, they should be connected to the code-activated switch* via the P6 port on the MAC (section (3.4.2.2).

3.0 RTAPS OPERATION

The following section shows how to set up and operate RTAPS components.

3.1 WOS

WOS.EXE is the file containing the executable code for performing communications between an IBM-compatible PC and μMAC acquisition computer. WOS must be executed with the cable configuration between the μMAC and PC shown in figure 9. The cable must provide an interface between the PC's COM1: port and μMAC port P5.

*You do not have to use a CAS. The software interface is provided to expand the number of serial ports available. If you are using serial (RS232) monitoring devices (such as the Seabird deck unit or mini-ranger), we recommend you include a CAS in your configuration and use P6 for all sampling I/O. Leave P5 available because it is used by RTAPS/MAC to transmit error message and to provide WOS communications.

3.1.1 Data Communications. The following communications configuration is used:

Baud	:	9600
Parity	:	None
Data	:	8 bits
Stop	:	1 bit

No additional hardware handshaking lines are used.

3.1.2 Execution. Once the communications cable has been connected, power applied to both μMAC 5000 and PC and the latter booted, enter:

A> WOS <return>*
B> WOS <return>
or C> WOS <return>

*Depending on the current logged drive

WOS may also be executed from an alternate disk volume by entering:

A> (Vol) *WOS <return>
B> (Vol) *WOS <return>
or C> (Vol) *WOS <return>

(Vol) is the disk volume where WOS.EXE is resident (i.e., a, b, c, and d).

The graphic WOS should appear on the screen along with the copyright and version number. RTAPS.MAC software should execute under versions 1.0, 1.1, and 1.3.

The MACBASIC prompt "." should appear. If it does not, perform the actions described in the following steps:

3.1.3 Troubleshooting.

a. ENTER <return> If it (".") appears, go to paragraph 3.2.

b. If it still does not appear, enter CX (depress the control key [CTRL], C and X simultaneously.)*

*This is the reset entry for the μMAC system. It can be used under WOS or terminal control at almost any time to reset the system without clearing any program resident in RAM.

c. If it still does not appear, check the following items or perform the following actions:

1. Cabling is properly configured (see figure 19)

2. Power applied to μMAC 5000 light-emitting diode (LED) on 5000 master board is illuminated)

3. DIP switches on μMAC 5000 are set for WOS communication (see μMAC 5000 operation manual)

4. Cycle power on 5000 master board

5. Check physical wiring connection on 5000
   Note: The screw terminal i/o connectors on the card cage (2-, 4-, and 7-board) housings occasionally fail to make connection on initial contact.

6. Check to insure P5 is connected with the COM1: port or the PC.

d. After performing steps 1 through 6, go back to 3.1.2.

3.2 Entering the Acquisition Program

3.2.1 Loading RTAPS.MAC. Once the "." prompt appears, the RTAPS.MAC software must be loaded into memory unless the program was previously entered and retained (battery backup) in RAM.* The program is contained on a PC disk-file called RTAPS.MAC. To load the program, enter:

.Enter "RTAPS.MAC" <return>

If the file is resident on a volume other than the current logged disk, invoke the volume name (i.e., a, b, c, or d).

The MACBASIC program will be compiled into an executable object code on the μMAC. The process requires 8 to 10 minutes to complete. If the battery backup was configured (hardware jumper option; see μMAC 5000 Operation Manual) on the master board, the program does not need to be reloaded until it is erased from memory (see the "new" command in the μMACBASIC Command Reference Manual). Occasionally, a power surge or unexplained event will cause an error in execution requiring recompilation (this is a rare event).

The loading process is complete when the "." prompt reappears.

3.2.2 Initialization. Once the "." prompt appears on the screen, the program is ready to run. At this point, you must have a pre-prepared initialization file resident on one of the PC's available disk drives. If the initialization file has not been prepared, enter:

^z (depress the control [CTRL] and 'z' keys simultaneously)

*See the μMAC 5000 Operation Manual for battery-jumper installation.

The preceding entry forces an exit from the WOS environment. At this point, MS-DOS is executing from the current logged disk. To resume WOS, simply reenter the sequence described in section 3.1.2.

Note: Once RTAPS.MAC has been compiled (loaded) into the μMAC, it will remain in RAM in an executable form until the system is "cold-reset" or power is cycled (unless the battery backup is used and the resume DIP switch is enabled; in this case, the program will be retained even under the above circumstances). Therefore, it is not necessary to reload the program each time WOS is used.

3.3 Running RTAPS.MAC

Once the RTAPS.MAC software is loaded, the simple command:

```
.RUN
```

<return> will force execution. The following display will appear:

```
>> μMAC 5000 Acquisition Program:  GREETINGS! <<
 > Options: 1). Initialize Table. 2). List current. 3). Sample.
 > Option number ?
```

3.3.1 Description of Options

3.3.1.1 Option 1. Initialize Table Entry. The initialization table must be contained within a disk file resident on the host computer system (section 3.4). The sample initialization file used is "t.int".

Selecting option 1 forces the following prompt display:

```
                        >>> INITIALIZATION <<<
> File name ?
```

Enter the name of the prepared initialization disk file <cr>.

Note: If the file does not yet exist, you may leave the working environment by enter ^z (depress the CTRL and z key simultaneously). At this point you will return to the host computer's operating system environment. Run any text editor to prepare the file (see section 3.4). After file preparation, rerun WOS. Remember, you will not be prompted at this point, so you must enter the file name before proceeding. Alternatively, you may choose to return to the main (run level, section 3.3) program. This may be done by entering a nonexistent file name or ^CX.

If the file name is entered improperly or does not exist, the following display will appear:

```
                        >>> INITIALIZATION <<<
> File name ? t
*** file not found, CONTINUE (C) or EXIT (E)?
```

At this point, an entry of "C" will allow the reentering of the file name. Enter "E" to return to the main level (section 3.3).

If the file name has been entered correctly, a table output listing will be directed to the screen. Figure 15 will be generated from the initialization file shown in figure 14.

```
0,06,ph00,00.0,
1,05,tm00,00.0,
/,
/,
0:-,
/,
```

Figure 14. Simple initialization table specifying input from analog channels 0 and 1 only. μMAC output is directed through P5 with no subchannel requirements.

```
                        >>> INITIALIZATION <<<

> File name ? t.int
>> End of File Encountered.  5 Records Read.

     -> Port P5 output characteristics.  P5 is 'on".

     -> Port P6 output characteristics.  P6 is 'off'.

++++++++++++++++++++++++++++++++++++++++

++++++++++++++++++++++++++++++++++++++++

chan    ident    range    delay    type

========================================

0       ph00     6        0        analog
1       tm00     5        0        analog

========================================

Setting up analog channels.
>> Julian date?
```

Figure 15. Display resulting from initialization table.

3.3.1.1.1 File Read Errors. When an error is encountered in the initialization file, the following message will be displayed:

```
>>> INITIALIZATION <<<

> File name ? t.int
0,06,ph00,01.0,
1,05,tm00,d0.0,
/,
** Error in input file read, Rec #2
> Origin: Table
```

Rec # N is actually the pending line number within the initialization file at the point of error detection. Additionally, the file will be listed to the screen as it is interpreted by RTAPS/MAC. In the above example, the error occurs at line #2. A "d" was placed in the delay field where only a numeric input was acceptable. The initialization file listing will halt when an error is detected. Depending on where the error occurred, the last or second to last input line will be displayed.

3.3.1.1.2 Common Errors. The most common errors detected within the file access cycle are listed below:

- Substitution of an alpha for numeric character, such as "o" for "0" or lower case "L" for "1".
- Failure to separate fields by commas. Each field must be separated by a comma, regardless of whether it is on a new line.
- Substitution of "." for ",".
- Failure to separate functional blocks by the "/" character. See section 3.4 for description of analog, digital, and output block entries within the initialization file.

3.3.1.2 Option 2. List Current. Selecting option 2 provides a table of the current sampling configuration resident within the acquisition system. Output may be directed to the PC screen display or the PC's printer. RTAPS/MAC will prompt for the output device specification when this option is selected. Figure 16 shows an example of an option 1 selection prior to initialization. This selection will cause a "Fatal Error 12" message to appear.

Simply stated, the initialize option 1 must be selected prior to listing or initiation of sampling. However, the list current (option 2) will allow the operator to ascertain whether an initialization table has been previously entered and document the I/O options controlling RTAPS/MAC operations. If an error condition has occurred, the "." prompt will reappear, allowing the entry of another run command or exit to prepare the initialization file (^z). The initialization file preparation is described in section 3.4. Interactive initialization from the host computer is not allowed.

```
                    >> Sample Table Configuration <<

* runid:

* Number of input channels:              1

Sample input table

++++++++++++++++++++++++++++++++++++++++++++++++

++++++++++++++++++++++++++++++++++++++++++++++++

Chan      Ident     Range      Delay      Type

================================================

0                     0          0        digital

================================================

*Data outputs directed to:
```

Figure 16. List current table options selected without prior initialization (option 1).

Note: File-based initialization "forces" the requirement for documentation and allows greater uniformity in terms of channel assignments, ranges, etc.

Once initialization has been completed, the list current (option 2) may be selected without generating errors. Figure 17 shows a sample initialization file. Figure 18 shows the table output generated from figure 17. No distinction is made between ASYNC RS232C and TTL-parallel digital channels in the hard-copy table output. The main purpose of the list current option is to verify channel selections and to document run cycles. The table output should be retained for future reference.

Note: The date printed in the Sample Table Configuration (figure 18) is the value of the real-time clock at the time of the listing (not the time of sampling).

3.3.1.3 Option 3. Sample. Once initialization has been performed, RTAPS/MAC is ready to accept signal inputs and route output records at the selected sampling interval. Selecting option 3 causes the system to transit into a "readiness state." At this time, the clock is running with the current date/time, but no sampling is being performed. If the code-activated switch is part of the system configuration, RTAPS/MAC will direct it to open all I/O channels.

```
00,06,tm00,00,
01,06,co00,00,
02,06,do00,00,
03,06,tu00,00,
04,06,fr00,00,
05,06,fl00,00,
06,06,nr00,00,
07,06,np00,00,
08,03,dp00,00,
09,01,ph00,00,
10,01,cu00,00,
/,
13,00,fa99,00,fa,
14,00,sbco,00,sb,14,
17,00,sbtm,00,sb,14,
15,00,mrx0,00,mr,13,
16,00,mry0,00,mr,13
/,
0:-,    <----------
/,
cal
xx,0,10
xx,1,10
xx,2,10
xx,3,100
xx,5,100
xx,7,100
xx,9,10000
xx,10,10000
fr,4,5
fr,6,7
sa,1,0
ph,9,-76.8,11.8,9.18,7.42
ln,7,1.18,.061
off
/
twindow
19,13,45,0
19,14,00,0
/
tsplot
ncol,100
nsamp,2
header,2
0,9.0,19.0
1,26.0,36.0
2,0.0,20.0
7,0.0,20.00
9,7.5,9.5
3,0.0,100.00
5,0.,40.0
13,0.,20.
10,0.0,-100.0
off
/
label
0,temp. (deg-c)
1,salinity (ppt)
2,dO2 (mg/l)
3,% rel trans.
5,chla (fluor.)
7,turb (ntu)
9,ph
10,cu++ (mv)
13,depth (m)
/
pplot
tinc,60.
13,15.00,1.00
10,-120,-80
3,90,60
0,10.8,11.3
/
end
```

Figure 17. RTAPS initialization sample file. Arrow location indicates extent of information used by the RTAPS.MAC software subsystem.

```
>> Sample Table Configuration <<

* runid:  test        Date:  6/19/85     01:04:43.9

* Number of input channels:  16

Sample input table

++++++++++++++++++++++++++++++++++

++++++++++++++++++++++++++++++++++
Chan    Ident    Range    Delay    Type

==================================

  0     tm00       6        0      analog
  1     co00       6        0      analog
  2     do00       6        0      analog
  3     tu00       6        0      analog
  4     fr00       6        0      analog
  5     fl00       6        0      analog
  6     nr00       6        0      analog
  7     np00       6        0      analog
  8     dp00       3        0      analog
  9     ph00       1        0      analog
  10    cu00       1        0      analog
  13    fa99       0        0      digital
  14    sbco       0        0      digital
  17    sbtm       0        0      digital
  15    mrx0       0        0      digital
  16    mry0       0        0      digital

==================================

* Data outputs directed to:  P6: SC#1

* SERIAL INPUT CODES *

>> SEABIRD:  P6 SC#4 (Code activated terminal output #4)

>> MINI-RANGER:  P6 SC#3

* Sampling interval:  3 seconds.  (Sampling interval selected during
  initialization)
```

Figure 18. List current table output format.

No prompt will appear during the waiting interval. RTAPS/MAC is waiting for the transmission of a single character to either the P5 or P6 RS-232 port. The character is "g".

The operator may choose to enter the "g" character prior to leaving the WOS environment. This action will not cause any damage or failure in execution. Output records will simply be routed into whatever is or is not listening.

Otherwise, the operator may return to the MS-DOS environment (remember ? ^z) and run RTAPS/PC (section 3.5). RTAPS/PC will trigger sampling by sending the "g" start character upon execution.

3.3.1.4 Interactive Entries. Following the initialization file input, update the clock and sample rate associated with the pending sample interval. The following prompt sequence and entry descriptions are used:

Prompt: >>Julian date ?
Response: Enter the integer Julian date <cr> (ie., the day of the current year numbered from 1 or January 1 through 365/366.)

Prompt: >>Time (h,m,s) ?
Response: Enter the current 24-hour clock time in hours <comma> minutes <comma> and seconds <cr>.

Prompt: >>Sample interval (sec) ?
Response: Enter the number of seconds between samples.

Note: If you are using the Mini-Ranger Falcon 484 system, your sampling rate should not be lower than 2.0 seconds.

Figure 19 shows the complete screen display for the initialization table/ interactive sequence shown above.

3.3.2 System Reset. At any time during program execution, the system may be reset by entering ^CX (depressing CTRL, C, and X simultaneously).

This action will produce the following results:

- Run time activity will cease.
- The following message will appear:

  ***** Restart *****

  followed by the "." MACBASIC prompt.

- All values entered during the previous initialization sequence (section 3.3.1) will be retained.

Sampling may be resumed by entering "run" and selecting option 3 (section 3.3.1.3) or by entering "sample" <cr>.

```
> File name ? t.int
0,06,ph00,01.0,
1,05,tm00,00.0,
/,
/,
0:-,
/,
>> End of File Encountered.  6 Records Read.
      -> Port P5 output characteristics.  P5 is 'on'.
      -> Port P6 output characteristics.  P6 is 'off'.
```

chan	indent	range	delay	type
0	ph00	6	1	analog
1	tm00	5	0	analog

```
Setting up analog channels.
>> Julian date ? 189
>> Time (h,m,s) ?  14,45,15
>> Run id ? test
>> Sample interval (sec) ? 2.0
```

Figure 19. Sample initialization sequence display.

3.3.3 Run-time Interrupts. The run-time interpreter allows certain interrupts during sampling. The WOS configuration (P5 connected to terminal or COM1: at 9600 baud, none, 8, 1) is required. Version 1.0 allows the following operational entries:

Status
Pause
Halt
Frequency

The interrupt is enabled by depressing the Escape key. The following prompt will appear:

```
console interrupt
?
```

A description of allowable entries follows:

3.3.3.1 Status.

Enter "S" <cr>. The following message will appear:

```
STATUS:
id: #recs time
Julian date:
```

# recs	is the number of output records transmitted during the current run cycle.
time	is the current time.
Julian date	is the current date.

3.3.3.2 Pause. Enter "p" <cr>. The following prompt will appear:

> Enter <cr> to resume sampling.

At this point the system has ceased sampling and is waiting for a carriage return to resume.

3.3.3.3 Halt. Enter "H" <cr>. The program will respond with an end sampling message and return to the "." MACBASIC prompt. Return to section 3.3 for reinitialization instructions.

3.3.3.4 Frequency. Entering F<time> will change the sampling interval. time is the new sampling period in seconds. For example:

? F 1. 0 <cr>
will change the sampling period to 1.0 seconds.

3.3.4 Data Output Format. RTAPS/MAC will run in a completely stand-alone manner after initialization. It requires no external communications with a host computer. The output data records may be tapped by any external device. Therefore, a well-defined output record format (see figure 20) is required to allow the interpretation of information by any available machine (provided it has an RS232C port that operates at 9600 baud).

The output is an ASCII string. The format is

// h, m, s, jd, ch_1, ch_2... ch_n, <cr>

// = start of record	jd = Julian date
h = time of sample (hours)	ch_1 = data field 1
m = minutes	ch_2 = data field 2
s = seconds	<cr> = carriage return

Figure 20. ASCII record format.

3.3.4.1 Channel Sequencing. The channel data fields are not individually identified by channel number in the output record (see figure 21). Records are compressed to speed transmission time and reduce storage requirements. The actual order of channel output is

a. Analog channels - Values representing designated channel numbers are output according to their entry sequence in the initialization table.

b. Fathometer - Only one BCD fathometer channel may be present in the system. If the fathometer input is used (as indicated by the entry code, section 3.4), the depth value will immediately follow the last analog channel value field in the output record.

```
// 17,22,55.3, 189,13.63, 1.473,
// 17,22,56.3, 189,13.63, 1.473,
// 17,22,57.3, 189,13.63, 1.473,
// 17,22,58.3, 189,13.63, 1.473,
// 17,22,59.3, 189,13.63, 1.473,
// 17,23,0.35, 189,13.63, 1.473,
// 17,23,01.3, 189,13.63, 1.473,
// 17,23,02.3, 189,13.63, 1.473,
// 17,23,03.3, 189,13.63, 1.473,
// 17,23,04.3, 189,13.63, 1.473,
// 17,23,05.3, 189,13.63, 1.473,
// 17,23,06.3, 189,13.63, 1.473,
// 17,23,07.3, 189,13.63, 1.473,
// 17,23,08.3, 189,13.63, 1.473,
// 17,23,09.3, 189,13.63, 1.473,
// 17,23,10.3, 189,13.63, 1.473,
// 17,23,11.3, 189,13.63, 1.473,
// 17,23,12.3, 189,13.63, 1.473,
// 17,23,13.3, 189,13.63, 1.473,
// 17,23,14.3, 189,13.63, 1.473,
```

Figure 21. Two-channel data output format (1-second sample period).

c. Mini-Ranger - The x-value will follow the fathometer (if used). The y-value will follow the x field.

d. Seabird - If used, up to four channels may follow the Mini-Ranger, fathometer, or analog value fields.

e. AUX1 and AUX2 - will follow. These channels are not currently defined for any specific device.

Note that although the system is currently configured for 24 channels, the output record does not necessarily contain 24 data fields. Undesignated channels are not represented in the output.

Version 2.0 of RTAPS/MAC will eliminate the requirement for special sequencing considerations. In other words, channel data fields will be output in exactly the same sequence as specified in the initialization table.

Note: RTAPS/PC automatically compensates for the channel sequencing anomalies. The actual physical location of the data in the output stream is transparent. The user refers to channel numbers in processing exactly as they were assigned in the initialization file. In other words, when using RTAPS software, channel 13 will always be referenced as channel 13 regardless of its input type or its order in the initialization file records.

3.3.4.2 Precision. Generally, only four digits will appear in the output data fields. This level of precision will be maintained even if exponentiation is automatically implemented. Each data field will be comprised of one sign byte, up to four ASCII numeric bytes, and a decimal point (six bytes total). The number of characters expands to nine if exponentiation is used and a variable number if a "precision" option is included.

The level of precision is only applied to the analog input levels. Refer to section 3.4.2.1 for the precision command. Four to eight significant digits may be selected.

3.3.5 Mini-Ranger (Falcon 484) Setup. The Falcon 484 is specifically designed to operate under the control of an external computer. However, you must enter specific information, such as location of reference stations, prior to the automatic RTAPS control implemented during run-time. This initial programming sequence may be performed using Motorola's Control Display Unit (CDU) or via the μMAC during RTAPS/MAC initialization.

The programming sequence using a CDU is described in section III of the Mini-Ranger Falcon 484 Positioning System Users Manual (Motorola Document 68-P06170Y).

Programming the Falcon 484 via RTAPS/MAC is automatically enabled if the "mr" code designation was used in the initialization table (section 3.4). Following the ">sample interval (sec) ?" prompt and user entry, the following display will appear:

```
>> Mini-Ranger Comm. Phase.  Your prompt is '$'.
 > Enter '#" <return> to exit.

$IT01,01,03

$
```

At this point, RTAPS.MAC has opened a communication link with the Mini-Ranger. It has also set the Mini-Ranger's internal clock in sync with the clock on board the μMAC using the Falcon's"IT" command. The following message appears if the communications link is opened improperly or the Mini-Ranger is not on line:

```
** No Response from Mini-Ranger.  Try Again.
```

If this message appears, check the cabling and Mini-Ranger baud rate settings (9600,n,8,1) and enter <cr>.

If a CDU is being used for programming the Falcon 484, the interactive phase may be terminated by entering:

```
"#" <cr>
```

Otherwise, the Mini-Ranger may be programmed using the command codes (mnemonics) described in section IV of the previously referenced manual.

Note: While using RTAPS/MAC to program the Falcon 484, all specific communications protocols are handled internally. In other words, the user is not required to enter control characters (e.g., DCI, ACK, NAK, STX, ETX, etc.) as part of the interactive entries. These functions are provided automatically by the communications interface. For example, an entry described in the manual may specify:

(STX)OM0,0,3(ETX)

From the RTAPS/MAC environment, the operator must enter:

$ OM0,0,3 <cr>

Once communications with the Mini-Ranger has been concluded, RTAPS.MAC is ready to begin sampling (section 3.3.1.3).

3.4 Initialization File Format.

The function of the initialization code is to obtain the information necessary to document channel assignments for subsequent control of the sampling operation. Channel numbers and their assigned identities are read from a disk file designated by the user under the control of the WOS communications software provided by Analog Devices. The records comprising the disk file are standard ASCII text established through the use of a word-processing or line-editing package.

Note: If a word-processing package is used, make sure that the file is created using the nondocument option. Embedded characters used for special processing may result in a misinterpretation of the input file by RTAPS.

The WRITETABLE procedure is included in this description. It is a means of verifying the results of the file read and documenting the sample run setup.

3.4.1 Input File Name. The suggested name of the input file may be up to eight characters in length followed by a ".int" extent.

3.4.2 Record Field Delimiters. Within the initialization input file are three segments. They are used to control I/O operations and are entered in the following sequence:

a. Analog input channels.

b. Digital input channels.

c. Digital (RS-232c) output configuration.

A sample input table is presented in figure 22. The three segments are separated by the "/" character.

```
                                        Comments

00,05,TB00,00.0,          *   Bow thermistor is ch #00.  Analog.
12,06,XXXX,00.0,          *   General input ch #12.  Analog.
01,05,BB00,00.0,          *   Bioluminescence (broadband) ch #1.  Analog.
04,05,FL00,00.0,          *   Fluorometer signal ch #4.  Analog.
05,04,FR00,00.0,          *   Fluorometer range ch $5.  Analog.
07,01,PH00,00.0,          *   pH ch #7.  Analog
/,                        **  End analog channel definitions.
13,01,TM00,00.0,sb,12,    *   Seabird input is RS232 and assigned ch #'s
14,02,CO00,00.0,sb,12,        13,14 and 15. Attached to P6 switch port #2.
15,03,CO00,00.0,sb,12,
20,00,MR00,00.0,mr,13,    *   Mini-Ranger input is RS232.  X is ch #20 and
21,01,MR01,00.0,mr,13,        Y is 21.  Input on P6 switch ch #3.
22,00,RAD1,00.0,aux1,14,  *   Future use.
23,00,DISC,00.0,aux2,01,
19,00,FA99,00.0,fa,       *   Fathometer is assigned channel #19.
/,                        **  End digital channel definitions.
-:1,                      *   Output will be routed to P6 smart-switch
                              channel #1.
/,                        **  End table input.
```

Figure 22. Sample RTAPS/MAC initialization table.

Note: Each parameter is separated from the next by a ",". A comma is also present at the end of each input file record. The example also shows comments present at the end of most of the input lines. The controlling software ignores any text present in the input record past the delimiter of two spaces.

3.4.2.1 Analog Channel Setup. The analog channels must be designated by the channel number that corresponds with the physical connection to the input terminals on the master/add-on μMAC board. In the present configuration, the channels must number from 0 to 23. The record syntax is

CC,RR,IDID,DDD...,

Where:

CC is the input channel number.

RR is the range associated with the channel (see the μMAC 5000 programming manual for input range voltage levels. The range defines the input voltage levels).

IDID is a four-character identifier associated with the input.

DDD... is a real value, which represents the delay factor associated with the measurement due to sensor response (either owing to the inherent latency of the sensor or an in-line delay caused by the flow-through pump residence time) measured in seconds.

The representation of analog input channels within the output data record may be altered by using the precision statement. The statement must be contained within the initialization file and must be the first line entered. The syntax is

```
precision,n
```

Where:

precision	is a key word that notifies RTAPS that the analog output precision value is contained in the next field.
n	determines the number of digits per analog channel in the output records.

The default value is 4.

An example is shown below.

```
precision,6,
00,06,tm00,00,
01,06,co00,00,
02,06,do00,00,
03,06,tu00,00,
12,06,cr00,00,
13,06,c100,00,
14,06,or00,00,
15,06,os00,00,
08,03,dp00,00,
09,03,ph00,00,
10,03,cu00,00,
11,03,cu01,00,
/,
04,00,fa99,00,fa,
05,00,mrx0,00,mr,11,
06,00,mry0,00,mr,11,
/,
0:-
**end RTAPS/MAC section
/,
rfile
vol,a:
size,300000
/
cal
xx,0,10
xx,1,10
xx,2,10
xx,3,100
xx,13,100
xx,15,1000
xx,8,100
xx,9,10000
xx,10,10000
xx,11,10000
fr,12,13
fr,14,15
sa,1,0
```

```
ph,9,-106.6,-21.6,8.875,7.458
/
tsplot
ncol,100
nsamp,2
header,2
0,20.0,30.0
1,18,23.0
2,3.0,7.0
9,8.3,8.6
10,-100.0,-200.0
/
label
0,temp. (deg-c)
1,salinity (ppt)
2,dO2 (mg/l)
3,% rel trans.
13,chla (fluor.)
9,pH
10,cu++ (mV)
11,cu++ #2 (mV)
7,Turb. (rel nepth)
15,Oils fluor.
04,depth (M)
8,sample depth (M)
/
pplot
tinc,360
device,7470
buffer,2
4,5,25
0,21,27
1,17,25.
9,8.4,8.6
10,-100,-200
 3, 25,75
13,0,50.0
15,0.0,50.0
/
end
```

3.4.2.2 Digital Channel Setup. Digital channels are either RS-232c or parallel TTL. At present, only the fathometer input is the latter type. The source of the serial (RS-232c) channels must be specified in terms of their physical origin. Also, the code-activated switch* may be connected to either

---

* In this case, the code-activated switch is a Western Telematics CAS-41. The syntax for the digital input channel definition is

CC,RR,IDID,DDD...,Code ,ISC

P6 is the recommended μMAC I/O port.

port (P5 or P6) on the μMAC 5000, so you must designate the subchannel associated with the multiplexing device. Specific drivers are presently defined that associate serial input devices with their respective input channels for only two types. These are the Seabird deck unit and the Motorola Falcon 484 navigation system.

Where:

CC is channel number associated with the digital input type. Any available channel from 0 to 23 may be assigned. The physical input port is not associated with the channel number, as is the case with analog inputs. RR is the range value. Although at present it is not used, this value must be specified. Its use is reserved for future applications.

IDID is the four-character identifier associated with the channel input.

DDD... is the delay factor (see section 3.4.2.1).

Code is the code associated with the input driver. At present, there are five codes defined. They are

- sb: Seabird deck unit.
- mr: Mini-Ranger.
- aux1: Auxiliary input device #1.*
- aux2: Auxiliary input device #2.
- fa: Fathometer input.

ISC is the input designation for the specific device. The input syntax is

- I: The input port ("0" for P5, "1" for P6).
- SC: The subchannel # (if the code-activated switch is connected, 1-4 is the port subchannel number for the physical connection to the switch).

Note: There are no field separators (commas) between the port and subchannel designators for the digital input channels. The serial input codes may have more than one channel assigned. For example, the Seabird unit may have up to four individual data channels; the Mini-Ranger, two; and each of the auxiliary ports, three. In the input table, the channel/subchannel entry must designate the same physical channel/subchannel for a code entry associated with a single physical device. You can enter a different port/subchannel for the same coded channel. However, the second and subsequent entries will be ignored.

In the example presented in figure 22, TM00, C000, and C001 are all input from the Seabird deck unit. They are recorded as channels 13, 14, and 15 with no delay and are input through P6, port #2 on the code-activated switch. Subsequent channels are input in a similar manner.

---

* No device drivers have been developed for aux1 and aux2.

3.4.2.3 Output Configuration. Two ports are available on the μMAC 5000. They are called P5 and P6. For the physical I/O cabling, the μMAC 5000 Operations Manual should be consulted, as well as section 2 of this manual.

In the RTAPS system, the code-activated switch is an integral part of the I/O constitution. There are two specific subfields within the output designation field. These are separated by a ":". The first specifies the output characteristics of P5; the second, P6. There are three allowable conditions per port. These are

a. -: This entry indicates that the output is not routed to this port.

b. 0: The output is directed to this port. However, no subchannels are associated.

c. 1...4: The output is directed to this port. The code-activated switch is attached and subchannels are targeted according to the number sequence.

eg. -:0 No output is directed through P5. Output is directed through P6. However, no switch is attached to P6 and the output is direct with no special communication considerations.

0:134 Output is directed through P5 and P6. P5 does not have a switching device attached. However, P6 does. Further, P6 requires output directed through ports 1,3, and 4 on the switching device.

In figure 22, output is directed only through P6, subchannel 1. Subchannels are defined as specified physical ports on the code-activated switch. The μMAC output port is physically connected to the modem input on the switch. The subchannels are the labeled terminal connections on the switch.

3.5 Running RTAPS/PC

RTAPS/PC runs within the BetterBASIC environment under MS-DOS 2.0 or higher. The language itself must be configured for RTAPS application (see section 2.5).

The following steps may be used to load and execute the RTAPS/PC package:

c >b <cr>*

*C > is the logged drive volume. <cr> is carriage return (enter).
User response is underlined.

The program b.com (and associated BetterBASIC modules) need not be on the logged disk drive.

The following display will appear:

BetterBASIC Rev 1.1
Copyright (C) 1984, 1985 Summit Software Technology Inc.
Left: 205152 bytes

Ok

3.5.1 Loading RTAPS/PC. The "Ok" prompt has the same function as most varieties of BASIC. At this point, enter:

Load "RTAPS.PC"
The "Ok" prompt will reappear after a few moments.

3.5.2 Start-Up. To execute the program, simply enter: Run

The following display will appear:

>>> RTAPS/COMPAQ Storage and Processing ===> Initialization.
>> Please enter name of initialization file:

The initialization file is the same one previously prepared and used for RTAPS/MAC initialization (section 3.4). For RTAPS/PC processing applications, certain modules are appended to control storage, processing, and display tasks performed by the PC. Section 3.6 describes the module entry syntax and the functions each module defines/controls. The responses shown are examples.

Figure 23 shows a typical working initialization file. The file name is T12A.INI. So, in response to the prompt:

>> Please enter name of initialization file: T12A.INI <cr>

RTAPS/PC next prompts:

>> Enter 4-character run identifier: KBUB <cr>

It will be used for documentation of storage files (see section 3.6.1.3 for explanation).

RTAPS/PC next prompts:

>> Data from file (f) or COM1 Input (c)?

RTAPS/PC allows the user to specify a disk file recorded during a previous RTAPS execution period or the COM1: port as the data source in post-processing or real-time (latter option).

If the data source is RTAPS/MAC, enter "c" <cr>. If it is a file, enter "f" <cr>.

```
00,06,tm00,00,
01,06,co00,00,
02,06,do00,00,
03,06,tu00,00,
04,06,fr00,00,
05,06,fl00,00,
06,06,nr00,00,
07,06,np00,00,
08,03,dp00,00,
09,01,ph00,00,
10,01,cu00,00,
/,
13,00,fa99,00,fa,
/,
-:1,
/,
cal          <----
xx,0,10
xx,1,10
xx,2,100
xx,3,100
xx,5,100
xx,7,100
xx,9,100000
x,10,100000
fr,4,5
fr,6,7
sa,1,0
ph,9,-76.8,11.8,9.18,7.42
ln,7,1.18,.061
off
/
tsplot
ncol,100
nsamp,2
header,2
0,9.0,19.0
1,26.0,36.0
2,0.0,20.0
7,0.0,20.00
9,7.5,9.5
3,0.0,100.00
5,9.,40.0
13,0.,20.
10,0.0,-100.0
/
```

```
label
0,temp. (deg-c)
1,salinity (ppt)
2,dO2 (mg/l)
3,% rel trans.
5,chla (fluor.)
7,turb (ntu)
9,pH
10,cu++ (mV)
13,depth (M)
/
pplot
tinc,300.
13,20.00,0.00
0,10,12
1,30,32
2,4,10
3,100,50
9,8.0,8.5
5,10,30
10,-250,0
off
/
end
```

Figure 23. Initialization file. Arrow points to beginning location of module definitions.

If the "f" option was selected, RTAPS/PC prompts:

>> File name?

Enter the name of the prerecorded source data file.

RTAPS/PC next prompts:

>> Enter 80-column (MAX) comment:

Enter a comment (single line) to associate with the pending data storage and processing. This comment will be used as a heading in graphics output.

Following the comment line entry, RTAPS/PC will access the initialization file and read channel information used by RTAPS/MAC as well as module entries intended for RTAPS/PC. The RTAPS/MAC information is used to obtain channel definitions for RTAPS/PC, not to set up sampling as in RTAPS/MAC. Notice the module processor prompts, which appear in the upper left-hand corner of the screen. During the module entry phase of the file read (text in file appended to RTAPS/MAC section). The same messages will appear as prompts during real-time module entry and will indicate the current type of module information being evaluated.

When the file access is complete, the system will prompt:

>>> Ok to continue?

If no errors have occurred, enter "y". Otherwise, enter "n".

If an error has been detected, it most likely results from an incorrect module entry or a hidden character embedded within the initialization file Check the initialization table carefully.

3.5.3. Run-Time. Following a "y" response to the ">>> Ok to Continue?" prompt, RTAPS/PC will begin reading data from the specified file or signal RTAPS/MAC to begin sampling and route data to RTAPS/PC in real-time. At any point during the data access interval, the operator may interrupt RTAPS/PC by depressing the defined function keys.

RTAPS/PC version 1.0 displays nine function key options during run-time. Of these, key options 6, 7, and 8 are reserved for real-time navigation display to be used in version 2.0. The other seven operational function keys are described below.

a. <F1> Halt. Depressing this key will produce the following effects:

1. Data input from file or RTAPS/MAC will be discontinued. If the source of the data is RTAPS/MAC, data acquisition will continue. However, input data will be ignored.
2. All outstanding open files (including sequential recording files) will be closed. Table files will be updated.
3. RTAPS/MAC will continue to sample.
4. The display will return to the start point (section 3.5.2).

b. <F2> Pause

1. Acquisitions, display, and processing will be discontinued pending the entry of a <cr> by the operator.
2. No files are closed.
3. Processing will continue upon operator response.
4. Data may be lost in real-time if the pause is sufficiently long and no external in-line buffering device is used.

c. <F3> Newmod

1. Allows entry of new processing module (see section 3.6 for description).
2. Module will be implemented following completion of entry.

d. <F4> Chdisc

1. Updates and closes recording and table files.
2. Prompts the user to insert another formatted disk (if the hard drive is used and there is sufficient space, or the floppy has room, the disk does not have to be changed).
3. Creates new recording and table files with extended update (section 3.6.1.3).
4. Returns to run-time environment.

e. <F5> Time

1. Displays the time of the sample record in the lower left corner of the display during processing.
2. Effect on processing: slows down recording/processing when selected.

f. <F9> Display

1. Displays measurement values associated with channels 0-11 (RTAPS/PC version 1.1) on the bottom two lines of the operator display.
2. Effect on processing: slows down recording/processing when selected.

3.5.4 Termination. Once executed, RTAP/PC is similar to a turnkey system. When actual processing has completed, the display will indicate a return to the start-up (section 3.5.2) point. At this time, enter ^break (Depress ctrl and break keys simultaneously) to leave the RTAPS/PC operating environment. In fact, you can exit the program at any time by performing the ^break function.

Caution: If data are being recorded and you must halt sampling, always use the <F1> halt key rather than ^Break to exit the run-time environment. This will insure the proper update sequencing and closure of files used during run-time.

3.6 Module Definitions

Modules are used to direct RTAPS/PC's storage and processing activities. They are incorporated into the initialization file following the RTAPS/MAC entry sequence.

3.6.1 rfile: Sequential Data Storage. The key input entry rfile informs the module interpreter that incoming data from the μMAC 5000 or the data file currently being read will be recorded in a standard ASCII MS-DOS text file. This file will be referred to as "sequential" in subsequent text.

3.6.1.1 Instructions. There are currently three instructions available within the rfile module: Size, Vol, and cd.

3.6.1.1.1 Size

Syntax: size, n

Size: Is a simple word of text informing the module interpreter that the sequential file size will be set.

n: The size of the sequential data file in bytes.

```
Example:        rfile
                Size, 300000
                /
```

This example is a complete module entry instructing RTAPS that input data are to be recorded in a sequential data file and the maximum size of that file is 300,000 bytes.

Note: The default size is 300,000 bytes. The maximum size of files recorded to DS/DD floppy disks is 316 Kbytes.

3.6.1.1.2 Vol

Syntax: Vol, Volname

Vol: Informs the module interpreter that the next argument contains the disk volume name.

Volname: Is the name of the disk drive where the sequential file will be created, generally "a:", "b:", or "c:".

```
Example:    rfile
            vol, a:
            /
```

This example is a complete module entry instructing RTAPS to write input data to a sequential file on drive "a:".

Note: If the volume is not specified and the rfile module is invoked, the data file will be created on the default (logged) disk drive.

3.6.1.1.3 cd

Syntax: cd

This command allows RTAPS to store sequential data in an ASCII text file format compatible with the standard (uncalibrated) data text after calibration has been performed. This allows more rapid treatment of data in postprocessing.

Note: The storage of uncalibrated and calibrated data are mutually exclusive (i.e., you cannot do both).

3.6.1.2 More Examples

```
/
rfile
/
end
```

This is a complete module entry that informs the module interpreter the input data will be recorded in a sequential file, which will be created on the logged drive (default) and 300 Kbyte in size (default).

```
/
rfile
size, 200000
/
end
```

This file contains the same instructions except for the size of the sequential file, which will be 200 Kbytes.

```
/
rfile
vol, a:
/
end
```

This table causes the direction of data into a 300 Kbyte (default) sequential file on floppy drive "a:".

Finally,

```
/
rfile
size, 128000
vol, a:
/
end
```

Vol and size do not have to be entered in any special sequence or appear at all. As in most module instructions, they are entered optionally. See the example given in section 3.4.2.1 for an initialization file that includes the rfile module.

3.6.1.3 Sequential File Naming and Size Considerations

3.6.1.3.1 Creation of Files and File Names. File names are derived from the four-character run identifier entered interactively during initialization. RTAPS will search the designated disk volume as well as the logged disk and prevent the creation of duplicate files (which would destroy the existing file).

Three files are created when the rfile module is defined (two files if the data reside on the logged disk). One file will contain the sequential data records derived from the input source. The other file(s) are opened but are not updated until the chdisc (F4) or halt (F1) function keys are selected by the operator. They are then updated and will contain the number of records, channel information, and start/end times for the sampling interval contained in the sequential data file.

The file naming convention is

Sequential data file: runid.SD$

where runid is the four-character run identifier entered at initialization.

SD means sequential data $.

$ is an extent identifier. In the event that more than one file is created with the same identifier, the $ character is incremented to the next higher ASCII character. The lowest $ value is "a", the highest "z".

You can create up to 26 data file extents belonging to the same run identifier. This is very useful when the user requires the storage of a large amount of data on floppy disks or simply wishes to alleviate the documentation burden by determining how many files in the directory belong to a specific sample grouping.

The extent update is performed automatically whenever the chdisc option is invoked or reinitialization is performed using a previously defined run identifier.

Table file: Same as data file, except it is designated runid.st$

3.6.1.3.2 File Size. When a size has been specified or the default file size (300,000 bytes) is used, RTAPS will check the specified (or default) volume to determine whether there is enough space available to hold the required amount of data. If there is insufficient storage space, the following message will appear:

>> Error in file size designation. Disk is either too full or specified file size (XXXXXX) is too large. Remember, DS/DD disks can contain 320000 bytes (this application). Your present disk has XXXXXX bytes remaining.

>>> TO STOP THE ANNOYING NOISE, PRESS FUNCTION KEY 4.

Press <F4>. The display will present the following options:

OPTIONS:
1). RE-ENTER FILE SIZE 2). INSERT NEW FORMATTED DISK OR 3). STOP.
>> Enter option (1,2 or 3) <CR>:

If option 1 is selected, the file size entered following the prompt

> Enter new file size:

must be smaller than the amount of space indicated in the above message.

If option 2 is selected and the recording medium is a floppy drive, the following prompt will appear:

> Insert new, formatted disk. <CR> to continue.
The third option ends program execution.

Caution: The file size used will be applied to subsequent files if reinitialization is not selected in the interim. In other words, if you use size 300,000 in the rfile module and only 116,000 bytes of storage are available and you indicate that the file size is acceptable, every file subsequently created during the chdisc operation will be 116,000 bytes long.

3.6.1.3.3 Changing Disk and/or Target Files. When the current file contains fewer than 10 Kbytes of remaining space, a warning beep will sound and the amount of space remaining will be displayed on the screen. To change the disk at this time, the user must depress the chdisc (F4) function key. The extent files will automatically be updated and closed, and new files will be created when sampling is resumed. The same action may be performed when you want to simply close the current files and create new ones on the target drive.

3.6.1.4 A Note on Run-Time Entry of rfile Module. Pressing the "newmod" function key (F3) allows the user to enter any kind of module, including rfile. rfile should not be entered using the "newmod" function while sequential recording is taking place (i.e., in real-time). You must halt sampling prior to entering an rfile module.

3.6.2 Cal: Calibration. This module regulates the calibration of input data from "coml:" or a sequential disk file.

3.6.2.1 Instructions. There are currently two input syntax forms. The first is simply the three-character string "off." This command informs the run-time processor that calibration is not to be performed on any input data. Any channel calibration information entered will be retained. When the module key cal is entered, the default state is "calibration on." So, if you wish to turn calibration off while on-line, use the newmod function and enter "cal" and "off" as the first record. The syntax is given below:

```
/
cal
off
/
end
```

To reinstate the calibration process, simply enter:

```
/
cal
/
end
```

The second entry syntax takes the following general form:

```
op,ch, C2 ,C3 ,C4 ,C5
where
op       is a two-character mnemonic operator
C1...C5  are argument values used in calibration
```

There are presently five operations available. They are

xx	software amplification
ln	linear (mx + b)
pH	nontemperature compensated mV/pH unit conversion
Sa	conductivity/salinity conversion
Fr	fluorometer channel range adjustment

The following paragraphs describe the module entry syntax.

3.6.2.1.1 XX,Ch,C2 Amplification

Ch is the integer channel number containing the value to be amplified.

C2 is the amplification factor (floating point decimal value).

"XX" differs from "ln" by the order of execution. Amplification is performed prior to the execution of any other cal instructions. In some situations you must use "XX" to produce engineering unit levels. For example, if conductivity is represented as an analog signal corresponding with 1 volt input per 10 mMHOS conductance, you must apply a 10-fold multiplication factor to represent engineering unit mMHO levels.

Note: for salinity (sa) conversion, the conductance must be in mMHOS.

3.6.2.1.2 ln,Ch,C2,C3 Linear Correction

Ch is the channel number containing the value used for conversion.

C2 is the slope of the linear model.

C3 is the y-intercept of the linear model.

3.6.2.1.3 pH,Ch,C2,C3,C4,C5

Ch is the channel number containing the mV input signal for conversion.

C2 is the mV signal level read from the meter (or A/D) during calibration that corresponds with the high pH buffer used.

C3 is the mV signal level read from the meter (or A/D) during calibration corresponding with the low pH buffer.

C4 is the high pH buffer (in pH units).

C5 is the low pH buffer (in pH units).

3.6.2.1.4 Sa,C1,C2

C1 is the channel number containing conductivity values.

C2 is the channel number containing temperature values (in deg-C).

Note: "XX" and "ln" are executed prior to "sa" during run-time.

3.6.2.1.5 Fr,Ch,C2

Ch is the channel number containing the fluorometer range input signal.

C2 is the channel number containing the fluorometer signal input.

Note: Range conversion is performed before linear "ln" adjustment. "fr" conversion is specified for the Turner designs 10000r fluorometer and all values are adjusted to the minimum scale values (*1.0).

3.6.2.2 Example

```
test.int
/
cal
XX,0,10
XX,1,10
XX,2,10
XX,3,100
XX,5,100
XX,7,100
XX,9,10000
XX,10,10000
fr,4,5
fr,6,7
sa,1,0
pH,9,-128,0,9,7
ln,7,1.23,5.0
/
```

3.6.3 tsplot: Time-Series Printer Plot. This module controls the hard-copy output of time-series data to the printer. This is not strictly graphics output and is designed to allow the use of a generic, Epson-compatible printer to depict channel information in a documented, time-ordered, hard-copy format. An example is shown in figure 24.

3.6.3.1 Instruction. The following options are available:

```
ncol
nsamp
headr
off
ch,min,max
```

3.6.3.1.1 ncol

Syntax: ncol,n

ncol is a text string informing the module interpreter that the number of columns reserved for plotting is contained in "n".

n is the number of columns used in the data field (excluding the time field and label overlap). For example, if you wish to plot over a specified interval and would like to distinguish a minimum resolution of .01, then ncol,n should be entered as ncol,100. This yields a 100-column field for plotting data. If the minimum column length (dictated by the printer characteristics) is less than 132, you may consider a "compressed" span for variables and "decreased" ncol width.

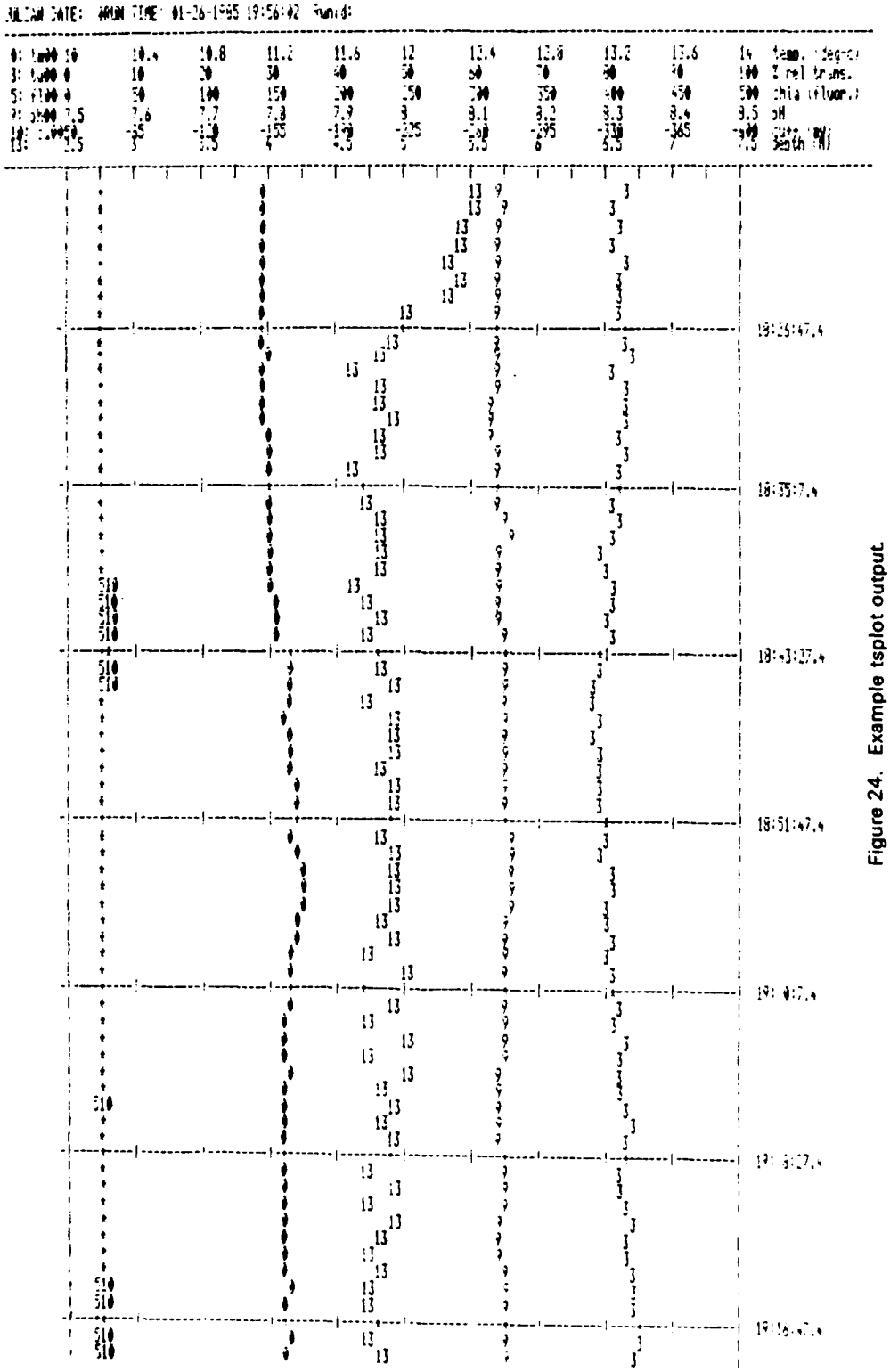


Figure 24. Example tsplot output.

3.6.3.1.2 nsamp

Syntax: nsamp,n

nsamp — is a text string informing the module interpreter that the sample module number for time-series plotting to a generic printer is contained in "n".

n — Represents the number of values to "ignore" prior to outputting a record to the printer (in other words, output every nth record).

3.6.3.1.3 headr

Syntax: headr,n

headr — is a text string informing the module interpreter that the header (i.e., axes, scales, label, etc.) should be reproduced every nth page of time-series printer plotting.

n — is the number of pages (forms) to continue "through" prior to outputting another header record.

3.6.3.1.4 off. The single-line entry of the word "off" clears the tsplot output to the printer. Subsequent data records are not retained until tsplot is once again invoked. This means that plotting will resume at the current (real-time) input record when tsplot is again initiated.

Note: During real-time acquisition or sequential-file post-processing, the function key F3 may be depressed at any time (newmods). At that point, the user may enter the key word tsplot. The channel information, nsamp, ncol, etc., is retained during the run-time segment of the program. So, if tsplot was specified in the initialization file or during a previous module entry (F3) interrupt, no additional information entry is required. The following sequence turns tsplot off:

user entry -> <F3>
user entry -> tsplot <return>
user entry -> off <return>
user entry -> / <return>
user entry -> end <return>

To reinitiate time-series printer plotting, use the following entry sequence:

user entry -> F3
user entry -> tsplot <return>
user entry -> /
user entry -> end

Invoking the tsplot entry module turns on the printer output automatically. The off entry suspends output.

3.6.3.1.5 Channel Information Entry

Syntax: ch,min,max or ch,off

ch is an integer channel number.

min is a real number containing the minimum scaling value for channel ch.

max is a real number containing the maximum scaling factor for channel ch.

off is a single word of text instructing the module processor to remove the scaling and plot output for the individual channel ch. This differs from the single line entry "off" in that the remaining channels are still included in the ongoing printer output records.

Example:

```
/
tsplot
1,10,12
2,30,35
3,-100,0
5,0,50
2,off
/
end
```

The output plot will contain channel information from Channels 1, 3, and 5 only. The default channel output state is "off".

3.6.3.2 Default States. The following states are active upon entry into the tsplot processor:

```
*ncol   =   100  (100-column plot space)
*nsamp  =     2  (plot every other input record)
*headr  =     2  (scales and headers will be printed every other page)

*Number of scale increments
        =    10  (not user selectable, automatically set)
```

3.6.3.3 More Examples

3.6.3.3.1 Initialization. Remember that all channels are off before the initialization file is read.

```
/
tsplot
ncol,200
headr,5
0,10,14
/
```

This is a complete initialization module entry. Nsamp is set to the default 2. Only one channel is being plotted (channel 0), and it is scaled between 10 and 14 units.

3.6.3.3.2 Real-Time (On-Line) Reconfiguration. The following examples will modify the configuration specified in the previous paragraph during program execution.

```
<F3>
tsplot
1,27.5,31.5
/
end
```

Add channel 1 to the plot output.

```
<F3>
tsplot
2,7.0,11.0
off
/
end
```

Adds channel 2 to the plotter output. Three channels (total) are now scheduled for plotting. Also, plotting has now been discontinued.

```
<F3>
tsplot
/
end
```

Reinitiates plotting. Three channels are now being output.

```
F3
tsplot
2,off
nsamp,5
headr,1
/
end
```

Turns channel 2 output off; changes the output record to once every fifth sample input. Also, the header is now plotted every page (the output is setup for 63 lines/page [header data]).

```
<F3>
tsplot
1,10,20
/
end
```

Channel 1 is now rescaled to 10-20 units full-scale.

3.6.3.4 Notes on tsplot

Character compression:	currently configured for output to an Epson (MX-80,FX-80,RX-80, or Mannesman Tally 160/180 using E-codes).
Channel limits:	There are currently no limits on the number of channels comprising the plot.
Time marks:	A clock-time field is included every 10th plotline. This function is not user-selectable.
Hardware and I/F	Output is directed to "lptl:".
Considerations:	The user should take care to perform spooling (either external printer buffer or internal) (e.g., AST superspl) configurations prior to running the RTAPS software.
Channel labels:	Channel labels for scale documentation are entered via the "label" module (3.6.4).

3.6.3.5 Example Output. Shown in figure 24.

3.6.4 Label: Channel Labeling. The label is a field identifying an individual channel. It may be any length (number of characters) up to 16 characters.

3.6.4.1 Instructions. There is only one allowable syntax within the label entry module.

Syntax: ch, S$

ch is the channel number targetted for label assignment.

S$ is a string of up to 16 characters comprising the label for channel #ch.

3.6.4.2 **Examples**

3.6.4.2.1 Entry from Initialization File

```
/
label
0,temp. (deg-C)
1,salinity (ppt)
13,depth (m)
/
```

3.6.4.2.2 Real-Time (On-Line) Label Entry

```
<F3>
label
0,temp. (deg)
1,salinity (ppt)
/
end
```

3.6.4.3 Notes on Label. Any valid channel number may have a label assigned to it. The label is used for tsplot and pplot documentation (axes, label information). Labels are not retained in any data recordings (i.e., within magnetically recorded information), so they must be reentered during each initialization.

3.6.5 pplot: Graphics Plotter Time-Series. This module controls the output format for an HP 7470 family of HP-GL-speaking plotters. The plotter must be plugged in to the COM2: port. Currently, a maximum of eight channels may be plotted using a single-time axis. Sample plot outputs are shown in figures 25A and 25B.

3.6.5.1 Instructions. The following instructions are available in the pplott module.

tinc	required
ch	required
device	optional
sfac	optional
buffer	optional
nsamp	optional

3.6.5.1.1 tinc

Syntax: tinc,t

tinc — is a key text string informing the module interpreter that the time increment is contained in the t parameter.

t — is a real value representing the unit of time. Two conditions are allowed, depending on the sign of "t".

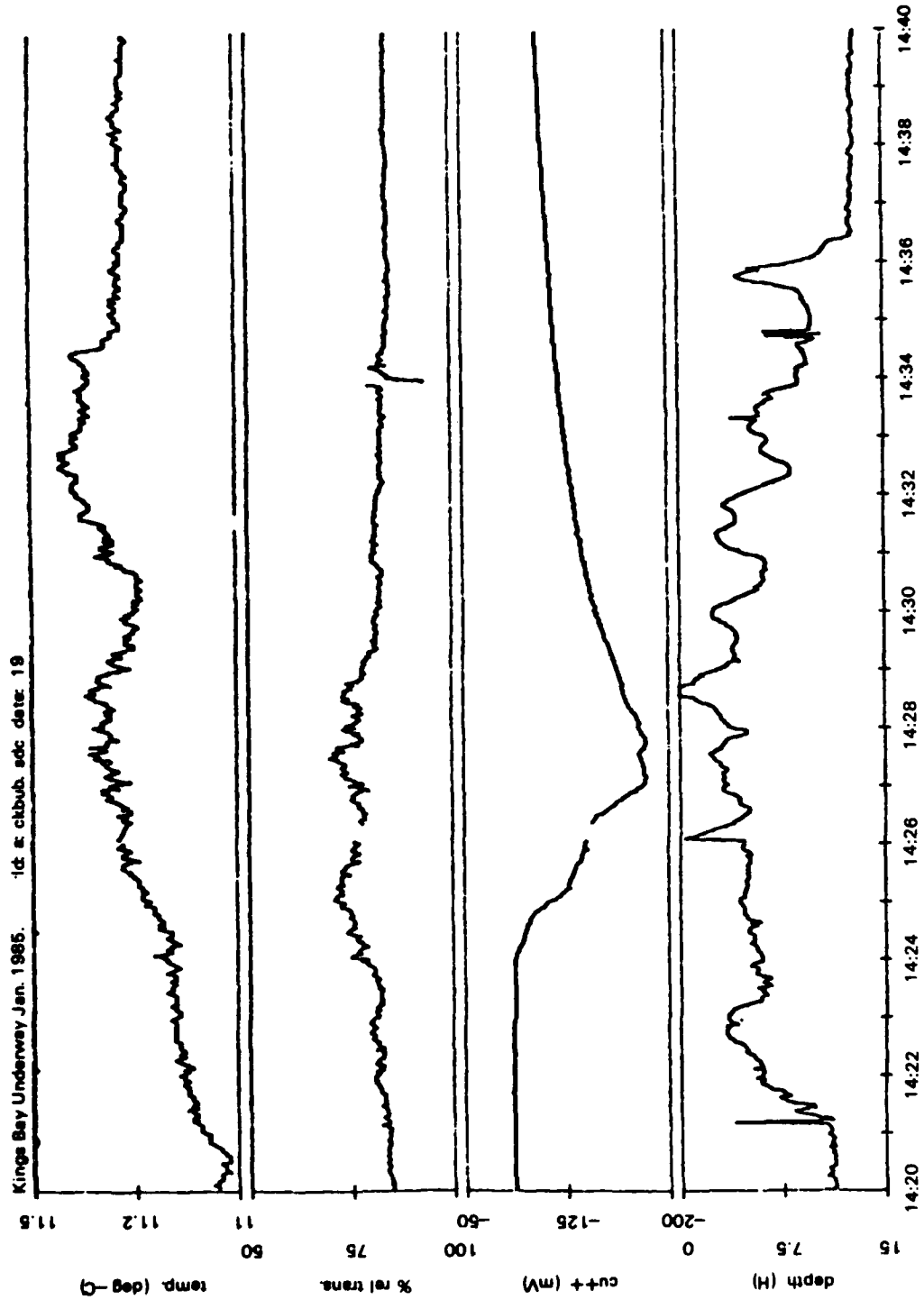


Figure 25A. Example pplot output (underway data).

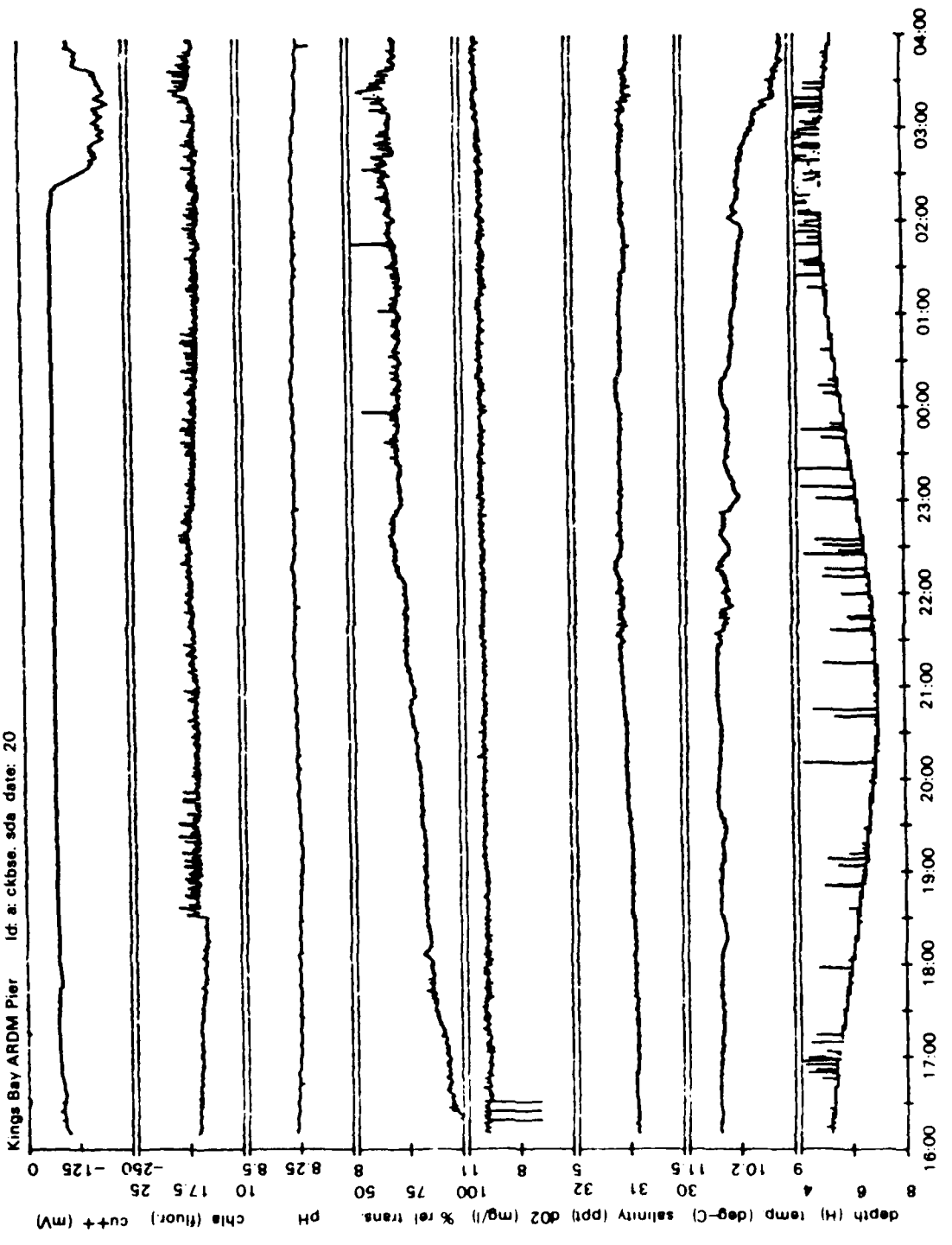


Figure 25B. Example pplot output (stationary time series data).

a. t<0 means the absolute value of "t" is to be interpreted as decimal hours.

b. t>0 means that the absolute value of "t" is to be interpreted as decimal seconds.

Note: If "t" is entered in hours, the time axis will be divided into 24 increments, each of which is time "t" apart from the preceding or proceeding value. The axes will be labeled in clock-time.
If "t" is entered in seconds, 20 increments will be allowed.

Time begins with the first record encountered within the data set or the record first accessed when the twindow module is used and extends through the data set (or to the twindow end point).

Example:

tinc,60 Means that increments will be 1 minute apart and will number 20 per plot.

tinc,-.5 Indicates that increments will be one-half hour apart and will total 24 per plot (12-hour series).

3.6.5.1.2 sfac

Syntax: sfac,x

sfac is a key text string informing the module interpreter that the manual plot scale factor is contained in the "x" parameter.

x is a real number scale factor regulating the size of the generated plot. The value must range between 0 and 1. It should not exceed the size of the scale factor automatically determined from the number of parameters to be plotted. Scale factors versus number of parameters are given in the table below:

Automatically generated relative scale factor versus number of parameters plotted.

Number of Parameters	Scale Factor
1-3	1.0
4	
5	
6	0.555
7	
8	0.455

3.6.5.1.3 ch

Syntax: ch,min,max

ch is the channel number to be plotted (integer).

min is the minimum scale value for channel ch (real).

max is the maximum scale value for channel ch (real).

Note: Channels will be plotted in their order of entry, beginning at the bottom of the page. There is no provision for automatic Y-axis scaling, since the program has no a priori knowledge of input ranges.

3.6.5.1.4 buffer

Syntax: buffer,n

buffer is a key word informing the module processor to set the pplot output buffer according to the value contained in n.

n is the number of input records to store prior to plotting. 2-20 points may be buffered.

Note: Channels are not individually buffered. All channels will accumulate the same number of points prior to executing the physical plot procedure. The advantage of buffering is that it increases the speed by decreasing the number of I/O commands routed to the plotter. The disadvantage is the inability to observe real-time changes in a field environment. n may assume the value range of 2-20.

3.6.5.1.5 nsamp

Syntax: nsamp,n

Note: The syntax and results are the same as those described for tsplot (section 3.6.3.1.2). The default is 1.

3.6.5.1.6 Device

Syntax: device,a$

device is a key word indicating the device is contained in a$.

a$ is the device specification. Currently, the entry may be 7470 (same as 7475) or 7550. The 7550 entry allows the use of the automatic paper feed on the plotter. Otherwise, there is no difference in the data treatment.

3.6.6 twindow: Acquisition/Processing Time Window. twindow is a time windowing feature used to start/stop recording and processing during a specified interval. When used, twindow should always be specified within the initialization file. Only a single interval may be selected during a run-time session. twindow may be used for plotting specified intervals within a data acquisition period or file or recording selected times to subset data files. It is currently available only for sequential data.

3.6.6.1 Instructions. Only two entries are required: start time and stop time.

Syntax: The first entry is

JD,h,m,s, <cr>

where:

JD is the Julian date
h is the hour (in 24-hr cycle)
m is the minute
s is the second

The next line contains the stop time and follows exactly the same syntax.

3.6.6.2 Example

```
twindow
207,10,50,0
208,05,13,0
/
```

This example starts sampling/processing/storage on Julian date 207 at 10:50:00 and terminates the next day at 05:13:00.

END

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